

The status of the frog fauna of the Werribee River catchment, southern Victoria, with notes on the utility of large databases in such an assessment

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Abstract

The Werribee River catchment, north and west of Melbourne, has experienced major change since European settlement, including the transformation or loss of native vegetation through agriculture and urbanisation. These changes are likely to have influenced the original frog fauna, although this cannot be confirmed since no broad-scale monitoring of the frog fauna in the catchment has been undertaken. Like all of Victoria's catchment areas, the main inventory of the frog fauna in the Werribee River catchment is the Victorian Government's Atlas of Victorian Wildlife database. Reliable records exist for 11 frog species in the Werribee River catchment, some dating back to 1959. Importantly, there are records for two species, Growling Grass Frog *Litoria raniformis* and Bibron's Toadlet *Pseudophryne bibronii*, which are officially threatened in Victoria. Species recorded from the catchment display a variety of ecological preferences (e.g. riverine specialists, semi-terrestrial breeders, burrowers, and wetland or slow-flowing river species), highlighting the importance of conserving and managing appropriately varied and interconnected habitats. In this paper, the Werribee River Catchment, a typical and recognised management unit, is used as a case study to examine the utility of available data for the management of frogs, and summarise the likely existing threats to this assemblage. (*The Victorian Naturalist* 128 (2), 2011, 36–47)

Keywords: Atlas of Victorian Wildlife, conservation status, Hylidae, frogs, Myobatrachidae,

Introduction

Many elements of the biodiversity of the Werribee River catchment, southern Victoria, are poorly known. In this paper, a summary is provided of the status and distribution of the frog fauna, a group for which there exists relatively little current information on distribution patterns within the catchment, and which is vulnerable to several acknowledged threats. Indeed, knowledge of some threats (e.g. chytrid fungus, climate change) appears to have developed substantially since some frog species were last recorded in the catchment (e.g. Pounds *et al.* 2006). A summary is also provided of the common threats to frogs, some of which are likely operating in the catchment, as well as comment on the utility of the Atlas of Victorian Wildlife (AVW; Department of Sustainability and Environment), a large government database, in assessing the current status of this assemblage, and the distribution of the frog fauna within the catchment in conjunction with hydrology and vegetation.

The Werribee River catchment

The Werribee River catchment, to the north and west of Melbourne, covers approximately 250 000 ha (1% of Victoria's land area), and in-

cludes the Werribee and Lerderderg Rivers as well as smaller tributaries such as Goodman, Parwan, Djerriwarrah, Kororoit and Skeleton Creeks (Fig. 1). The topography of the catchment is dominated by the Lerderderg Ranges, Brisbane Ranges and Pentland Hills in the north, and extensive basalt plains in the south (Department of Primary Industries 2008).

Prior to 1750 there was a mosaic of vegetation classes in the Werribee River catchment which included large swathes of grasslands and grassy woodlands across the central and southern regions. Since European settlement 67% of the catchment has been cleared for agriculture, primarily dryland grazing, and 5% of the southern catchment has been transformed by urbanisation, especially around the townships of Werribee, Melton and Bacchus Marsh (Melbourne Water 2004) (Fig. 2). At present, approximately one quarter of the catchment is covered by remnant vegetation, mostly comprising the Ecological Vegetation Classes (EVCs) Shrubby Foothill Forest and Heathy Dry Forest in varying degrees of modification. The Western Treatment Plant, managed by Melbourne Water, exceeds 11 000 ha and provides extensive frog habitats in the south of the catchment.



Fig. 1. Hydrology in the Werribee River catchment (DSE Corporate Geospatial Data Library).

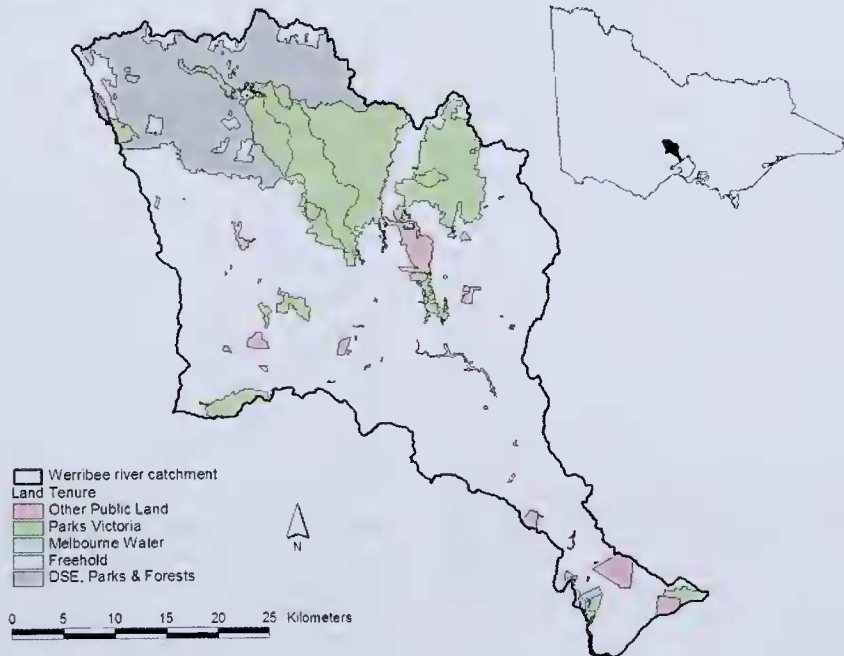


Fig. 2. Current significant land use classification of the Werribee River catchment (DSE Corporate Geospatial Data Library).

The frog fauna and the Atlas of Victorian Wildlife database

The current status of the frog fauna of the Werribee River catchment is poorly known. The Atlas of Victorian Wildlife database holds approximately 1900 frog records (to March 2009) for the catchment, dating back to 1959. These records cover four species of tree frogs (Family Hylidae) and seven species of southern frogs (Family Myobatrachidae). The tree frogs are the Southern Brown Tree Frog *Litoria ewingii*, Lesueur's Tree Frog *Litoria lesueuri*, Growling Grass Frog *Litoria raniformis*, and Verreaux's Tree Frog *Litoria verreauxii*. The Southern Frogs are the Common Froglet *Crinia signifera*, Victorian Smooth Froglet *Geocrinia victoriana*, Southern Bullfrog *Limnodynastes dumerilii*, Striped Marsh Frog *Limnodynastes peronii*, Spotted Marsh Frog *Limnodynastes tasmaniensis*, Common Spadefoot Toad *Neobatrachus sudelli* and Bibron's Toadlet *Pseudophryne bibronii*. Nomenclature follows Cogger (2000).

Information for each of these species, including conservation status, distribution (both broadly within Victoria and more particularly in the Werribee River catchment), and major habitat preferences, is presented below. The conservation status of each frog in state and national contexts is provided where appropriate listings exist and, based upon the records in the Atlas of Victorian Wildlife database, an assessment of the distribution within the catchment is included within the context of the species' broader distribution (Figs. 3, 4). Listings under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG) or the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC), statutory lists of threatened taxa, are also included. Categories for national and State conservation status, which follow those of the World Conservation Union (IUCN 2001), are derived from Environment Australia (2008) and Department of Sustainability and Environment (2007). The IUCN status of each species is also provided, and this is derived from the IUCN Red List website (<http://www.iucnredlist.org/>).

The Tree Frogs (Family Hylidae)

Brown Tree Frog (Ewing's Tree Frog) *Litoria ewingii* (Duméril and Bibron, 1841)

Distribution: The Brown Tree Frog is distributed across a large area of south-eastern Australia (from south-eastern NSW to Tasmania) (Cogger 2000). The Brown Tree Frog inhabits large areas of Victoria and is absent only from the north-western and north-central parts of the state. It has been commonly recorded throughout the Werribee River catchment, although most recent records are for the northern portion of the catchment and there have been no records since 2001 (Fig. 3).

Habitat: This is a cosmopolitan species that can be found throughout rural areas and cities alike. The Brown Tree Frog calls from and breeds in farm dams, ponds, creeks and waterholes; it tends not to be associated with fast-moving water (M Smithpers. obs). In the Werribee River catchment, this frog is associated with a broad range of vegetation classes, but most commonly recorded from Riparian Forests and Shrubby Foothill Forests (Table 1). It has been more commonly recorded from wetlands than from rivers or creeks.

Conservation status: IUCN Red List Status – Least Concern.

Lesueur's Frog *Litoria lesueuri* (Duméril and Bibron, 1841)

Distribution: Lesueur's Frog, the focus of a recent taxonomic revision (Donnellan and Mahony 2004), is distributed across a large area of eastern Australia. This frog ranges from south-eastern Victoria to north-eastern Queensland. Lesueur's Frog can be found from coastal areas through to the western side of the Great Dividing Range. This frog inhabits only the eastern half of Victoria. Within the Werribee River catchment it has been recorded only in the north (Fig. 3); the last record in the catchment was in 1990.

Habitat: Lesueur's Frog is a terrestrial species that, at least in the southern portion of its range, is typically regarded as a stream-dweller that is often found along rocky rivers with fast-flowing water. However, the frog is also often found some distance from water in habitats that range from dry sclerophyll forests through to rainforests and coastal heathlands. In the Wer-

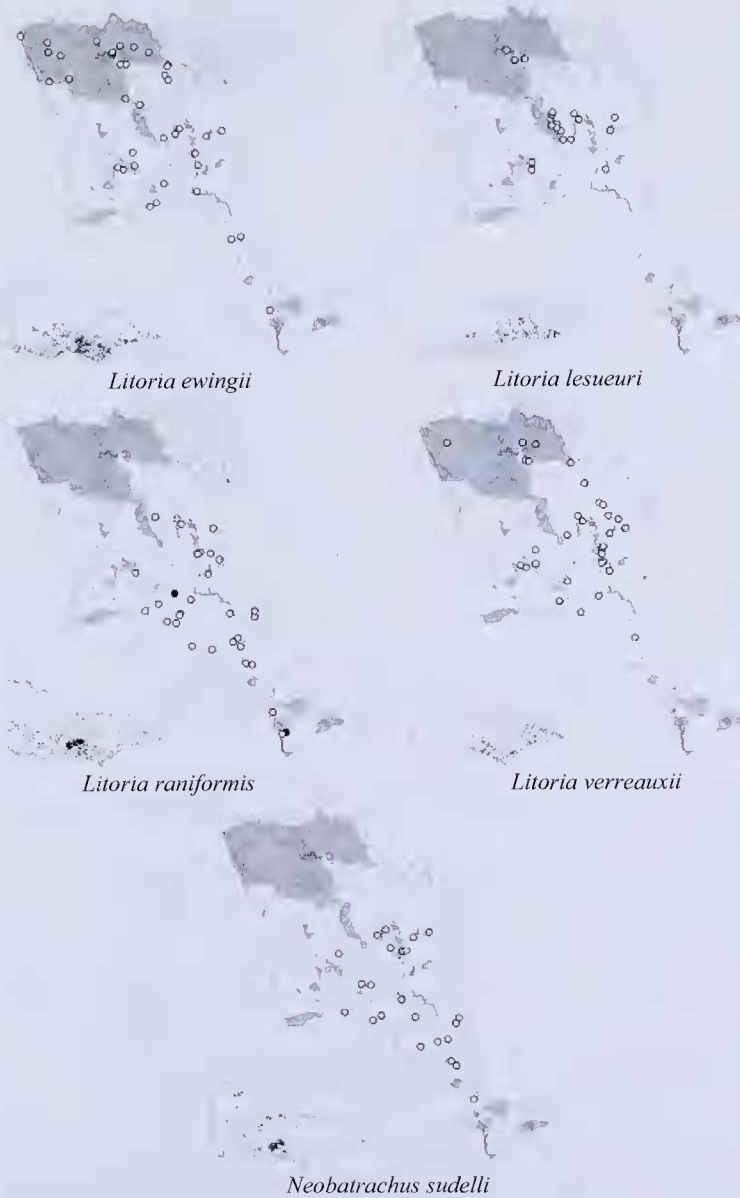


Fig. 3. Location records for four Hyloid and one Myobatrachid frog species in the Werribee River catchment and Victoria (Atlas of Victorian Wildlife, DSE). Shaded areas indicate land under government management. Records are shaded to indicate pre-2000 (white) and post-2000 (black).

ribee River catchment, Lesueur's Frog was most commonly recorded in Private Land or Stream Bank Shrubland EVCs and is associated mostly with riverine habitats (Table 1). The most recent AVW record was collected in 1990.

Conservation status: IUCN Red List Status – Least Concern.

Growing Grass Frog (Southern Bell Frog, Warty Bell Frog) *Litoria raniformis* (Keferstein, 1867)

Distribution: the Growing Grass Frog is distributed across a large area of south-eastern Australia (including Tasmania) ranging from as far north as Bathurst through the central and southern tablelands of New South Wales,

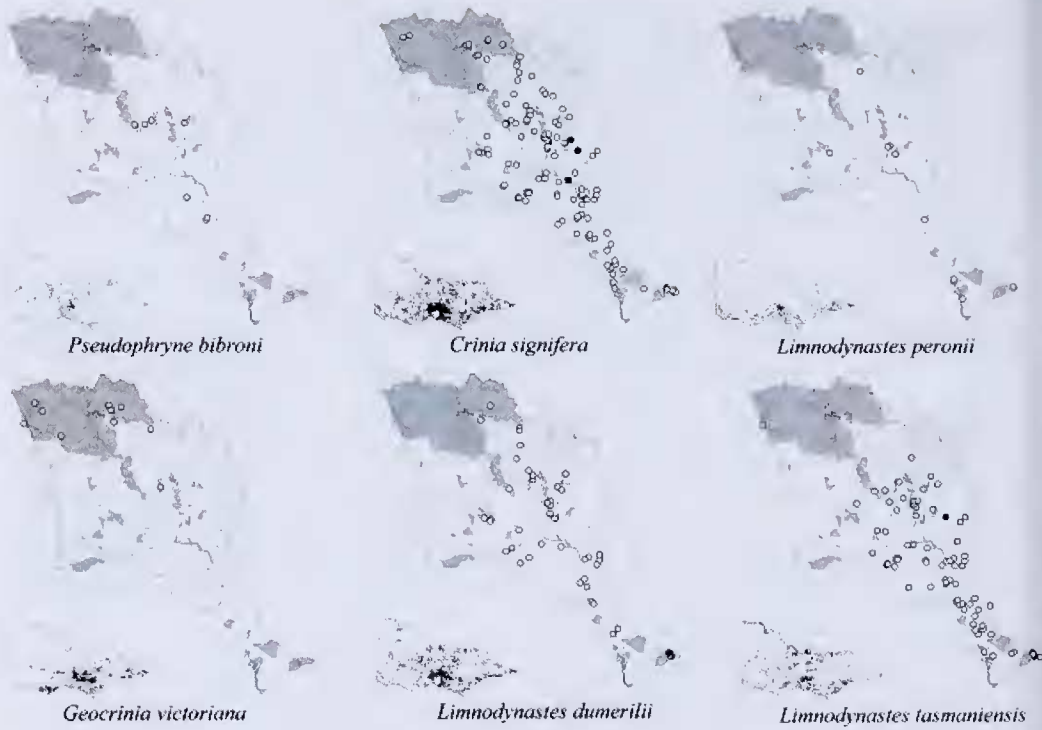


Fig. 4. Location records for six myobatrachid frog species in the Werribee River catchment and Victoria (Atlas of Victorian Wildlife, DSE). Shaded areas indicate land under government management. Records are shaded to indicate pre-2000 (white) and post-2000 (black).

and most of Victoria. The species also occurs in eastern South Australia. In the Werribee River catchment it is mostly recorded in the south-eastern half (Fig. 3) and records are reasonably equally divided between wetland and river habitats.

Habitat: the Growling Grass Frog is found in a broad range of habitats that include woodland, grasslands and areas of improved pasture (Table 1). The species is typically found in dams, ponds and marshes and appears to prefer aquatic and riparian vegetation from which it calls. It is often found sheltering under logs and rocks. In the Werribee River catchment, the Growling Grass Frog has been commonly recorded in the following EVCs: Box Ironbark Forest, Rocky Chenopod Woodland, Stream Bank Shrubland and Private land. While the most recent AVW records were collected in 2003, the Growling Grass Frog has been recorded since then from

the Western Treatment Plant (Aaron Organ unpubl. data) and the Werribee Open Range Zoo (Bev Drake, pers. comm.).

Conservation status: IUCN Red List Status – Endangered, Decreasing; Australia – Vulnerable; Victoria – Endangered, FFG listed.

Whistling Tree Frog *Litoria verreauxii* (Duméril and Bibron, 1841)

Distribution: The Whistling Tree Frog is distributed across a large area of eastern Australia. The frog ranges from south-eastern Victoria to southern Queensland, where it can be found from coastal areas through to the western side of the Great Dividing Range. In Victoria, the species inhabits only the eastern half of the state. It has been recorded mostly in the northern half of the Werribee River catchment (Fig. 3) and there are no records for the catchment since 1990.

Table 1. Percentage records for each frog species in each Ecological Vegetation Class (EVC) in the Werribee River catchment.

Records derived from Atlas of Victorian Wildlife (DSE) to March 2009. Dominant vegetation classes for each frog species, in terms of the percentage of total records, are highlighted in bold. Frog species: *L. ewi* *Litoria ewingii*, *L. les* *Litoria lesueuri*, *L. ran* *Litoria raniformis*, *L. ver* *Litoria verreauxii*, *C. sig* *Crinia signifera*, *G. vic* *Geocrinia victoriana*, *L. dum* *Limnodynastes dumerilii*, *L. per* *Limnodynastes peronii*, *L. tas* *Limnodynastes tasmanensis*, *N. sud* *Neobatrachus sudelli*, *P. bib* *Pseudophryne bibronii*.

EVC description	L. ewi	L. les	L. ran	L. ver	C. sig	G. vic	L. dum	L. per	L. tas	N. sud	P. bib
Coastal Saltmarsh					2.50				6.67		
Riparian forest	4.55	6.25			2.50	14.29					
Heathy Dry Country	27.27	12.50		14.29	22.50		15.00		6.67		
Shrubby Dry Forest	9.09	12.50	6.67	9.52	7.50	14.29	10.00	16.67	13.33		33.33
Grassy Dry Forest	4.55			4.76							
Herb-rich Foothill Forest						14.29					
Shrubby Foothill Forest	13.64	6.25		14.29	15.00	28.57	10.00	16.67			
Valley Grassy Forest		6.25		9.52	2.50						
Higher Rainfall Plains Grassy Woodland	9.09		6.67	9.52	5.00		10.00		13.33	28.57	16.67
Conifer Plantation						14.29			6.67		
Cleared Severely Disturbed					2.50				6.67	14.29	
Box Ironbark Forest	9.09	12.50	20.00	9.52	5.00		10.00		6.67	14.29	16.67
Rocky Chenopod Woodland	9.09		13.33	4.76	7.50		15.00	33.33	13.33		
Creekline Grassy Woodland					2.50						
Heavier-soils Plains Grassland					2.50				6.67		
Grassy Woodland				6.67	2.50				13.33		
Stream Bank Shrubland		18.75	13.33	4.76	2.50		10.00				
Private Land (no tree cover)	13.64	25.00	26.67	19.05	17.50	14.29	20.00	33.33	6.67	42.86	33.33

Habitat: This is a cosmopolitan species that can be found in rural areas and cities alike. The Whistling Tree Frog breeds in farm dams, ponds, creeks and waterholes. It tends not to be associated with fast-moving water. In the Werribee River catchment the species is associated with a broad range of EVCs that includes Heathy Dry Country, Shrubby Foothill Forest and Private Land (Table 1). This frog has been more commonly recorded in wetlands than in creeks or rivers.

Conservation status: IUCN Red List Status – Least Concern.

The Southern Frogs (Family Myobatrachidae)
Common Spadefoot Toad *Neobatrachus sudelli* (Lamb, 1911)

Distribution: The Common Spadefoot Toad ranges from south-central Queensland through central New South Wales and into western Victoria. In the Werribee River catchment the Common Spadefoot Toad has been recorded in the southern half of the catchment (Fig. 3), but the most recent AVW records originate from the Western Treatment Plant in 2002.

Habitat: The Common Spadefoot Toad is a burrowing frog that typically inhabits drier regions. The species is found in a range of habitats including woodlands, shrublands, mallee and open grassland. In the Werribee River catchment the frog typically has not been associated with riverine habitats; it has been recorded mostly from Private Land or Higher Rainfall Plains Grassy Woodland EVC (Table 1).

Conservation status: IUCN Red List Status – Least Concern.

Common Froglet (Common Eastern Froglet)
Crinia signifera (Girard, 1853)

Distribution: As its name suggests, the Common Froglet is one of the most common frogs in Australia. The Common Froglet occurs across most of Victoria, with the exception of the dry north-west. It appears to be common throughout the Werribee River catchment (Fig. 4) and the AVW contains records as recent as 2003.

Habitat: The Common Froglet occurs in almost every freshwater habitat within its range, including severely disturbed areas. These habitats include wet and dry forests, woodlands, alpine grasslands, floodplains and even freshwater soaks behind beach dunes. Adult frogs

shelter beneath rocks, logs, human debris and ground litter, usually close to water-bodies or in moist depressions, and it is not uncommon to find numerous individuals sheltering together.

In the Werribee River catchment the frog is associated with a broad range of EVCs, but has been most commonly recorded in Shrubby Foothill Forests, Heathy Dry Country and Private Land (Table 1). Records are more common in wetland habitats than river or creek ecosystems.

Conservation status: IUCN Red List Status – Least Concern.

Victorian Smooth Froglet *Geocrinia victoriana* (Boulenger, 1888)

Distribution: In Victoria, the Victorian Smooth Froglet is generally restricted to the south of the Great Dividing Range; it is confined to the cool and cold temperate zones in Victoria, from East Gippsland through the elevated midlands to the Grampian and Otway Ranges in the west. Around Melbourne, the Victorian Smooth Froglet occurs in the eastern and north-eastern suburbs, with some isolated records from the Mornington Peninsula, and Craigieburn to the north. In the Werribee River catchment this froglet has been recorded only in the northern part of the catchment, as recently as 1999 (Fig. 4).

Habitat: The Victorian Smooth Froglet is most often found in low vegetation near water-bodies in damp forests. In the Werribee River catchment, the frog appears to be restricted largely to Shrubby Foothill Forest vegetation (Table 1).

Conservation status: IUCN Red List Status – Least Concern.

Southern Bullfrog (Pobblebonk, Eastern Banjo Frog) *Limnodynastes dumerilii* Peters, 1863

Distribution: The Southern Bullfrog occurs throughout eastern and southern NSW, southern Queensland and south-eastern South Australia, as well as in most of Victoria, with the exception of the arid north-west corner. The Southern Bullfrog is found throughout the Melbourne area, but is most common to the north and south-east of Melbourne. Three subspecies occur within Victoria, two of which are found around Melbourne — *Limnodynastes dumerilii insularis* occurs on the Mornington Peninsula and in the eastern suburbs, and *Limnodyn-*

astes dumerilii dumerilii exhibits a distribution across central and northern Victoria that takes in the northern suburbs of Melbourne. Whilst morphologically similar, the two Melbourne subspecies can be distinguished because *Limnodynastes dumerilii insularis* usually has a clear pale mid-dorsal stripe and a stronger dorsal pattern of mottling, although a gradation zone between these two forms exists. *Limnodynastes dumerilii dumerilii* remains common throughout the Werribee River catchment (Fig. 4). The most recent AVW record for the species was in 2002.

Habitat: The Southern Bullfrog occupies all habitats with the general exception of some alpine environments, rainforest and some arid regions. It shelters in burrows, and beneath rocks and logs. In the Werribee River catchment the species has been recorded in a range of private and public land in both riverine and wetland ecosystems (Table 1).

Conservation status: IUCN Red List Status – Least Concern.

Striped Marsh Frog (Brown-striped Frog)
***Limnodynastes peronii* (Duméril and Bibron, 1841)**

Distribution: The Striped Marsh Frog is common throughout eastern Australia. In Victoria it is found in the eastern portion of the state, though rarely inland of the Great Dividing Range. The Striped Marsh Frog is generally common where it occurs, including the Melbourne area. Only a few AVW records of this species exist for the Werribee River catchment and none since 2001 (Fig. 4).

Habitat: The Striped Marsh Frog is found in a range of coastal and upland vegetation types, where there is permanent slow-moving or still water and plentiful aquatic or waterside vegetation. It prefers to shelter in reeds or thick grass, although it may often be found sheltering beneath debris.

In the Werribee River catchment the Striped Marsh Frog is known from both private and public land with most records originating from either the Rocky Chenopod or Private Land EVCs (Table 1). Records exist for both riverine and wetland habitats.

Conservation status: IUCN Red List Status – Least Concern.

Spotted Marsh Frog *Limnodynastes tasmaniensis* Günther 1858

Distribution: A very common species throughout eastern Australia, extending into eastern Northern Territory. The Spotted Marsh Frog is found across the state with the exception of the north-west and the highest elevations of the Great Dividing Range. Two races with different calls occur in Victoria; the southern call race occurs throughout and adjacent to the Melbourne area, including the Werribee River catchment. It is most common in the southern portion of this catchment and common on public and private land (Table 1); the most recent AVW record for this species in the catchment is 2003 (Fig. 4).

Habitat: The Spotted Marsh Frog is usually found in habitats associated with semi-permanent or permanent water, such as floodplains, flooded paddocks, roadside ditches and grassy streams and ponds and was recorded in a broad range of vegetation classes (Table 1). These habitats include forests, grasslands, woodlands and shrublands. It shelters in cracks in the ground, and beneath rocks, logs and debris left by humans. It is often particularly common in disturbed areas, and around farm dams. After heavy rain, this frog often breeds in ephemeral water such as flooded ditches and paddocks. Accordingly, the species was more commonly reported from non-riverine habitats.

Conservation status: IUCN Red List Status – Least Concern.

Bibron's Toadlet (Brown Toadlet, Brown Brood Frog) *Pseudophryne bibronii* Günther, 1858

Distribution: Historically, this frog was common throughout mainland eastern Australia, ranging from southern Queensland throughout most of New South Wales and Victoria and into south-eastern South Australia. Records for Bibron's Toadlet have been collected from a swathe of temperate sites in woodland, grassland or dry forest, in eastern and south-eastern Australia. In the Melbourne area, Bibron's Toadlet is limited to the northern and western suburbs and to the west of Port Phillip Bay, with some historical records from the eastern ranges. It is distributed throughout central Victoria, west of the Central Highlands to the South Australian

border. This toadlet appears to have declined over the last decade, and has now disappeared from or is rare in areas where it was once common. Relatively few records exist for the Werribee River catchment (Fig. 4); the most recent AVW records were collected in 1990.

Habitat: Bibron's Toadlet is a terrestrial species that is found in wet and dry vegetation associations from alpine grasslands and bogs to plains and foothills, where there is sufficient damp soil and cover. This secretive litter-dweller shelters under rocks, logs and debris. In the Werribee River catchment the species has been recorded mostly in Private Land or Shrubby Dry Forest EVCs (Table 1).

Conservation status: IUCN Red List Status – Near Threatened; Victoria – Endangered, FFG listed.

Threats to frogs

Habitat modification (including fragmentation) and destruction, in addition to the introduction to Australia of a virulent pathogen, the chytrid fungus, are two major threats to frogs that have recently been the focus of considerable research (Alford and Richards 1999; Alford *et al.* 2001). Other threats, such as increased UV-B radiation, introduction of predators (e.g. fish, foxes, cats) and other viruses (e.g. *Rana* virus), eutrophication and secondary salinisation resulting from farming practices and urban run-off (see Smith *et al.* 2007 for the impacts of secondary salinisation on frogs), plus climate change, may also be influencing the status of frog populations in Australia (Alford and Richards 1999). Parts of Victoria are predicted to become drier in coming years (Department of Sustainability and Environment 2006) and climate change is probably responsible for the extended recent drought in south-eastern Australia. Frog diversity may be adversely affected by drought (Laurance 1996) and habitat refugia could be critical during those periods. It is also likely that one threatening process acting alone will have less impact than several operating in synergy.

Suitable habitat is critical for the persistence of any organism. Since European settlement, large tracts of native vegetation have been removed in Victoria, and there is a general trend of wetland and riverine modification (Norman and Corrick 1988). Such changes can have

profound effects on frog diversity (Semlitsch and Bodie 1998) if considerable areas of habitat are removed or disturbed, as is the case for the Werribee River catchment. However, no consistent monitoring of frog populations has occurred during these disturbances, so we can only assume that at least some frog species have been adversely affected by these changes.

It is assumed that frogs in the catchment exist in spatially separated (isolated) populations which together form a metapopulation (Levins 1969; Petranka and Holbrook 2006). The persistence of a metapopulation as a whole is supported by the colonisation of new habitat and recolonisation of previously occupied habitat (made available through extinction of a local frog population). By modifying and removing freshwater habitats, inter-habitat distances can increase and accessibility of the remaining viable habitat decrease, with implications for frog dispersal, recolonisation and persistence, especially if the vegetation communities between breeding habitats have also been altered.

Extensive urbanisation that has occurred in the region will have resulted in the structural modification of many freshwater ecosystems (Norman and Corrick 1988). Changes could include physical modification, changed hydrological cycles, and vastly altered vegetation communities which are typically dominated by weeds. Road networks can have the effect of isolating water-bodies, hence restricting the movement of frogs and preventing opportunities for frogs to colonise new or previously occupied habitat (Vos and Chardon 1998) which is needed to assist in the persistence of the metapopulation.

The introduction to Australia of the chytrid fungus *Batrachochytrium dendrobatidis*, a pathogen that attacks the skin of post-metamorphic amphibians (Beebee and Griffiths 2005), may have led to cataclysmic population declines in many frog species (Alford and Richards 1999; Alford *et al.* 2001). The fungus appears to operate effectively in cooler climates (Pounds *et al.* 2006) and accordingly, higher-altitude frog species may be the worst affected. However, several low-altitude species also appear to have been affected by the fungus, suggesting that interactions between species, the fungus, and the environment are occurring (Berger *et al.*

1999). Infected individuals from several of the species that occur in the Werribee River catchment (e.g. Common Froglet, Southern Brown Tree Frog, Lesueur's Tree Frog, Spotted Marsh Frog and Southern Bullfrog) have been found in other areas, highlighting that some of the species in the catchment could be susceptible under the right circumstances.

Several introduced fish species have been identified as key predators of tadpoles and probably contributed to the decline of a number of frog species in Australia (Mahoney 1999). Some of these species have been recorded in the Werribee River catchment (J. Lieschke pers. comm.) — Carp *Cyprinus carpio*, Brown Trout *Salmo trutta*, Rainbow Trout *Oncorhynchus mykiss* and Mosquitofish *Gambusia holbrooki* have been identified as predators of tadpoles and possibly adult frogs and their eggs (Ans-tis 2002; New South Wales National Parks and Wildlife Service 2007).

The Red Fox *Vulpes vulpes* and the domestic Cat *Felis catus* are potential predators of frogs, but there is very little information on the predation rates and impact of these introduced mammals. Several studies of foxes and cats have documented the occurrence of frogs in their diets (e.g. Molsher *et al.* 1999; Read and Bowen 2001). Predation by cats and foxes, and possibly dogs, is likely to be a greater threat in developed areas; that is, the townships and western suburbs of Melbourne that fall within the southern section of the Werribee River catchment.

Discussion

The broad objectives of this paper were to summarise the current status of the frog fauna of the Werribee River catchment and assess the utility of a large institutional database, the Atlas of Victorian Wildlife (DSE), to provide baseline information for the management of the frog fauna in the catchment.

Eleven species of frog have been recorded in the Werribee River catchment, and were associated with both riverine and non-riverine freshwater ecosystems in both public and private land. The frog records in the catchment are mostly associated with the EVCs Rocky Chenopod Woodland, Box Ironbark Forest, Shrubby Foothill Forest, Shrubby Dry Forest and Heathy Dry Forest. The impacts on the frog fauna arising from the transformation of public

land in the southern portion of the catchment from previously dominant EVCs Plains Grassy Woodland, Heavier-soils Plains Grassland and Plains Woodland/Plains Grassland Mosaic to Treeless Private Land is unknown, although several frog species appear to still utilise Treeless Private Land.

The species in the catchment exhibit varied life-histories that include riverine specialists, wetland or slow-flow specialists and even a terrestrial species (Bibron's Toadlet). The persistence of the frog assemblage known from the catchment, should these species be extant, will depend mostly upon the availability of appropriate habitats. Riverine and wetland habitats should not be managed in isolation of each other as they are both likely to contribute substantially to the habitat requirements of the frogs in the region.

The AVW database does not appear to hold recent records for many of the frog species that are known from the catchment. For some species this can be attributed to the fact that the region has not been comprehensively surveyed and consequently, the current status and distribution of frogs in the catchment, especially in relation to available habitat (e.g. vegetation classes, wetlands), is difficult to determine. The lack of contemporary information on frog distribution and abundance highlights the major limitation of the database. Additionally, available data are largely presence data with little ecological information, which also diminishes its value, especially since information on land-use change, a major determinant of frog occurrence, can help identify and explain frog distribution patterns. Effort should be invested in locating and including other frog data for the catchment from universities, government organisations and departments, and non-government organisations.

For several species, the most recent records are more than a decade old — this is particularly worrying given that one of these species is the endangered Bibron's Toadlet. The catchment is inhabited by at least two threatened species, Bibron's Toadlet and the Growling Grass Frog. Recent records indicate that the Growling Grass Frog still persists in the catchment, although these records are predominantly in the largely artificial environments of the Western Treat-

ment Plant (Organ 2003, 2004) and the Werribee Open Range Zoo.

The database has several limitations that if rectified would make it more useful. The most important issue is that the apparent decline of several species within the catchment is not reflected in the database because of a lack of up-to-date records, most likely a consequence of both limited survey effort and the under-submission of records. This is highlighted by the most recent *P. bibronii* record which is more than fifteen years old. A critical function of the database is the provision of information that would allow the detection of species in decline or that have become locally extinct. To achieve this, the database would need ongoing maintenance, with regular updates from appropriate survey and monitoring programs. In its current form, and in conjunction with vegetation mapping, the database is useful in relating frog records to some spatial and environmental interrogation. Some species (e.g. *Geocrinia victoriana*, *Litoria lesueuri*, *Neobatrachus sudelli*) have not been recorded in either of the southern or northern halves of the catchment, distributions that correspond with the areas that have received the greatest amount of land clearing and urbanisation, while other species (e.g. *Litoria ewingii*) appear to be quite widespread in the catchment. Some information on the types of water bodies (e.g. rivers, wetlands) that the species use may be gleaned from these records.

At the time of writing, the Department of Sustainability and Environment was developing a more sophisticated successor to the AVW that will accommodate biodiversity records for all ecosystems (terrestrial, aquatic and marine) in the state, and capture more site-based information. This will go some way to addressing the shortcomings of the current system, although the issue of under-representation (due to lack of survey) for some biotic groups and locations will remain.

To improve the utility of the AVW (or its successor), at least for frogs of the Werribee River catchment, it is suggested that:

- (1) comprehensive and appropriate surveys that account for uncertainty in detection (e.g. Brown *et al.* 2007; Smith *et al.* 2007) are conducted;
- (2) an effective monitoring program is devel-

- oped to track the changes in population status over the medium- to long-term;
- (3) the AVW database is updated, and all available data are sourced and incorporated;
- (4) there is a need for ongoing and increased investment in the social aspects of frog conservation that includes more public participation in surveying and in providing data for the AVW.

More general recommendations for directing research to inform the management of the frog fauna in the Werribee Catchment include:

- (1) the development of a better understanding of the metapopulation structure of the different species and the impacts that habitat changes have made - best achieved with newly-developed genetic techniques (Rowe *et al.* 2006);
- (2) a better understanding of: (i) the effects of novel predators, (ii) the potential impacts of climate change and the availability of habitat refugia, (iii) the hydrological regimes within the catchment, and (iv) the likely impacts that different threatening processes have on key characteristics of freshwater environments;
- (3) the determination of the extent of chytridiomycosis infection in the catchment.

Conclusion

The frogs of the Werribee River catchment provide an instructive case-study. While the catchment is close to Melbourne and very accessible to study, relatively little current information exists for the frogs there, at least in the public forum (i.e. AVW). In Victoria there are about 30 similar drainage basins and, mostly, our knowledge of frogs in them is just as poor. A greater understanding of frog occurrence across Victoria and the processes that affect it is urgently required, especially in light of the myriad threats that are operating on this vulnerable animal group.

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